

What is claimed is:

1. A fluid pump comprising:

a bladder, at least a portion of the interior surface area of said bladder being changeable, said bladder having a fluid inlet and a fluid outlet;

means for alternately expanding and contracting the bladder to change the interior surface area and volume of said bladder; and

means for causing substantially one-way fluid flow through said bladder.

2. A fluid pump as in claim 1, wherein said expanding and contracting means comprises:

a housing around at least a portion of said bladder and defining a space between said housing and said bladder for receiving a bladder actuating fluid; and

means for alternately increasing and decreasing the pressure of said actuating fluid.

3. A fluid pump as in claim 2, wherein said actuating fluid is a gas and said pressure changing means comprises a vacuum pump.

4. A fluid pump as in claim 2, wherein said actuating fluid is a gas and said pressure changing means comprises a compressor.

5. A fluid pump as in claim 2, wherein said actuating fluid is a liquid and said pressure changing means comprises a hydraulic pump.

6. A fluid pump as in claim 2, wherein said actuating fluid is a gel.

7. A fluid pump as in claim 2, wherein said bladder and said actuating fluid are a unitary body of semisolid material.

8. A fluid pump as in claim 2, further comprising fluid flow regulating means in the space volume between said bladder and said housing.

9. A fluid pump as in claim 8, wherein said fluid flow regulating means expands and contracts selected areas of said bladder, in a filling phase, to expand a selected area of said bladder adjacent said inlet and thereafter progressively expand the remaining areas of said bladder towards said bladder outlet; and during an ejection phase to initially contract said bladder adjacent said bladder inlet and thereafter progressively contract the remaining areas of the bladder towards said bladder outlet.

10. A fluid pump as in claim 1, wherein a majority of the interior surface area of said bladder is changeable by at least a few percent.

11. A fluid pump as in claim 1, wherein said bladder comprises a latex material.

12. A fluid pump as in claim 1, wherein said means for causing substantially one-way fluid flow comprises at least one check valve.

13. A fluid pump as in claim 1, wherein said means for causing substantially one way fluid flow comprises an inlet check valve at said bladder inlet, and a outlet check valve at said bladder outlet.

14. A fluid pump as in claim 1, wherein said fluid is blood.

15. A fluid pump as in claim 1, further comprising means for controlling the expansion and contraction of said bladder.

16. A fluid pump as in claim 15, wherein said controlling means comprises at least one extensible strut spanning the interior of said bladder.

17. A fluid pump as in claim 15, wherein said means for controlling comprises one or more bands on said bladder.

18. A fluid pump as in claim 15, wherein said means for controlling comprises thickness variations in said bladder.

19. A fluid pump as in claim 1 for use as a ventricular assist device for a heart, wherein said outlet from said bladder is connected to the aorta of the heart.

20. A fluid pump as in claim 1 for pumping blood and comprising two said bladders working in combination to simulate the left and right ventricles of a heart.

21. A blood pump comprising  
a housing;  
an extensible and contractible bladder in said housing, defining a space between said housing and said bladder for receiving a bladder driving fluid, said bladder having an inlet and an outlet;  
a check valve to at least one of said bladder inlet and outlet; and  
means for altering the pressure of the driving fluid to alternately expand and contract the interior surface area and volume of said bladder, most of said interior surface area of said bladder adapted to expand and contract with each pumping cycle.

22. A blood pump as in claim 21, wherein said driving fluid is a gas, and said means for alternating pressure alternates the pressure between comparatively

high and low pressures, said high pressure being at or below atmospheric pressure, whereby application of said low pressure causes said bladder to expand and application of said high pressure causes said bladder to contract.

23. A blood pump as in claim 21, further comprising a fluid pressure regulator in said space to selectively control the rate of expansion or contraction of selected areas of said bladder.

24. A blood pump as in claim 21, further comprising at least one extensible strut spanning the interior of said bladder.

25. A blood pump comprising  
a housing;  
an extensible and contractible bladder in said housing defining a space between said housing and said bladder for receiving a pneumatic bladder driving fluid, said bladder having an inlet and an outlet;

at least one check valve to at least one of said bladder inlet and outlet; and  
means for selectively altering the pressure of the driving fluid to alternate between a filling phase and an ejecting phase; in said filling phase, to initially expand a selected portion of said bladder and thereafter progressively expand the remaining portions of said bladder; and during said ejection phase to initially

contract a second selected portion of said bladder and thereafter progressively contract the remaining portions of said bladder.

26. A method of pumping a fluid, comprising the steps of:  
providing an extensible and contractible bladder having an inlet and an outlet;  
connecting the inlet and outlet of the bladder to a fluid circulation system;  
expanding the interior surface area and volume of said bladder to draw fluid in through said inlet;  
closing said inlet; and  
contracting the interior surface area and volume of said bladder to expel fluid through said outlet.

27. A method as in claim 26, wherein the step of expanding the bladder comprises  
initially expanding a portion of said bladder adjacent said inlet, and  
gradually expanding the remaining portions of said bladder from said inlet towards said outlet.

28. A method as in claim 26, wherein most of the surface area of said bladder expands and contracts at least a few percent.

29. A method of pumping blood, comprising:

providing an extensible and contractible bladder having an inlet and an outlet;

connecting the inlet and outlet of the bladder to a circulatory system;

expanding a first selected portion of the interior surface area and increasing the interior volume of the bladder to begin to draw blood in through the bladder inlet;

progressively expanding additional portions of the interior surface area and further increasing the interior volume of the bladder to further draw blood through said inlet into said bladder;

contracting a second selected portion of the interior surface area and interior volume of the bladder to begin to eject blood through the bladder outlet;

and

progressively contracting additional portions of the interior surface area and further decreasing the volume of the bladder to eject additional blood through the bladder outlet.

30. A method of pumping blood as in claim 29 where said first and second selected portions of the bladder are substantially the same portions.

31. A method of pumping blood in the circulatory system of a human in need thereof comprising the steps of

(a) providing an extensible and contractible bladder having an inlet and an outlet;

(b) connecting the inlet and outlet of the bladder to the human's circulatory system;

(c) expanding a majority of the interior surface area of the bladder by at least a few percent and expanding the volume of the bladder to draw blood into the bladder through the inlet;

(d) contracting a majority of the interior surface area of the bladder by at least a few percent and contracting the volume of the bladder to pump blood out of the outlet of the bladder; and

(e) rhythmically repeating steps (c) and (d).